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Visual Aspect of Mine Evaluation; A Case Study

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ABSTRACT: Drill hole data allows for evaluation of the mine area under investigation. The topographical, stratigraphical and assay information are utilized to estimate the dimensions and reserve of the ore body. In this study, a 3 dimensional evaluation system for the topography and ore body has been developed. Input to the system is *x* (East), *y* (North) and z (elevation) coordinates of drill holes coupled with stratigraphical and assay values. The system provides modeling of the topographical surface and ore body blocks. A gridded surface is generated to represent the topography. Nodes on the grid are assigned *(x.y.z)* coordinates. Either inverse distance square method, geostatistical methods or neural network system can be used to interpolate the drill hole data through the area. Underground modeling is performed by interpolating available data to three-dimensional blocks, which represent the ore body. According to cut-off grade, blocks are classified as ore or waste. *(x,y,z)* coordinates and assay values of each block are stated in a special and familiar visualization technique, called as DXF format. The system provides the DXF formatted appearance of both topography and ore body as well as 3D drill hole distribution. Photograph-quality visualization js realized by processing in any DXF processing system like AutoCAD, Bryce and 3D Studio Max The reserve is also calculated. The system is coded in C++ and applied in the Çöllolar coal district. The results have revealed the validity of the system.

1 INTRODUCTION

Valuation is a crucial step of mining. The exploration data is evaluated and worth of site under investigation is determined. Reserve, shape, quality distribution and thickness are also determined at this stage. This information is valuable for future analyses. Economical aspect of the work is crucial as well as technical aspect.

In mine evaluation work, the topography, location of drill holes, ore body itself are required to be visualized in 2 dimensions and 3 dimensions. A successful and precise viewing enables seeing the invisible ore body. For this purpose, visualization takes an important role and Is an urgent aspect of evaluation. Since the introduction of computers, this fact has not changed. The computers have merely provided greater ease, speed and accuracy in visual evaluation.

Many evaluation techniques have been developed over time. The numerical results are also supported by visuals. Both academic (Roninson et.al-, 1998; Honerkamp and Mann, 1996) and commercial programs have been coded for a practical and accurate assessment (AutoDESK, 1987; Eagles, 1992; Gemcorn, 1992; Geostat, 1992; Medsystem, 1994; Sur-' pac, 1998). The commercial software allow for comprehensive applications. However, in some deposits having special geological features that software do not consider, they might not be used. In this study, a drill-hole based evaluation system has been developed. Any programmer engineer can develop own evaluation system by means of the approach employed in this study. The system is capable of 3D drill hole diagramming, 3D topographical and ore body modeling, and reserve estimation. The system is applied to a restricted part of the Çöllolar coal district in Elbistan, Turkey. In comparison to previous studies (Erarslan, 1991), reasonable results have been obtained, revealing the applicability and validity of the system.

2 SCOPE OF THE SYSTEM

The visual evaluation system is capable of determining the topographical structure, drill hole locations and ore body extensions in three dimension.

The drill hole *(x.y.z)* coordinates represent Easting, Northing and Elevation. They are used to form a uniform data structure on a superimposed grid system. Data interpolation is provided by inverse distance methods, geostatistics, or neural networks. The *(x,y)* coordinates on the grid can simply be calculated. However, for other parameters like the *z* coordinate, thickness, grade, etc., the special mathematical methods mentioned above are utilized. Thus, in general, interpolation is made for parameters other than Easting and Northing. The elevation is stated to be visualized.

In addition, the block model of the deposit is also a type of data interpolation performed for the ore blocks. The bench level data from drill holes are interpolated to 3-dimensional blocks. This interpolation is made either in the center of blocks or the corner points.

The visualization of drill holes is another capability of the system. The *(x,y,z)* coordinates of drill holes and their depths are used for modeling.

The developed system utilizes the output of all the extension methods mentioned above in a definite format The system can produce the data eXchange Files *(DXF)* format to describe the *(x.y.z)* coordinates of assigned grid points, drill holes and ore blocks. This is a special and familiar drawing format, which can be processed in several drafting packages like AutoCAD, 3D Studio Max and Bryce. Any mining engineering researcher can develop their own visualization system according to their needs. This is the major advantage of the DXF approach. Once the view is transferred to the drafting packages, any service provided by them can be used for the models.

3 APPLICATION OF THE SYSTEM

3.1. Çölloîar Coal District

The developed *system* has been applied in *the* Çellolar coal district, Elbistan, Turkey. The basin is the largest lignite region in Turkey with more than 3,500,000,000 tons of coal. The average calorific value is between 1000 and 1100 kCal/kg. The stripping ratio is 2.5:1 - 3.0:1. The coal seam İs irregular and tilts up slightly to the north. Drill hole exploration takes place in an area of 5.5 km (east-west) by *8.5 km.* (north-south)

3.2 Three Dimensional Visual Evaluation

The system is introduced using 239 drill holes from the ÇÖllolar district. Their *(x.y.z)* coordinates and depth information are used to represent their distribution in a 3-dimensional aspect. The location map of the holes is shown in Figure 1, while in Figure 2 the three-dimensional view is represented. As can be seen on the Figure 1 and Figure 2, the drill holes are distributed homogeneously, which provides a good and reliable base for further calculations. Figure 3 represents the grid structure superimposed on the district. The resolution of the mesh wire is 40x40 and the radius of influence is estimated to be 500 m in geostatistical studies. Figure 4 shows an isometric view of the drill holes and topography. The figures feature some exaggeration in the z coordinate since the displacement in the east-west and north-south directions is much more greater than the elevation difference.

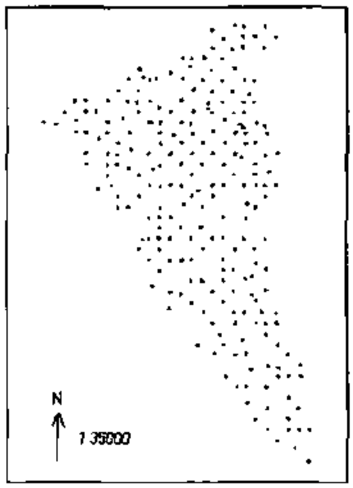

Figure I Location map of the drill holes.

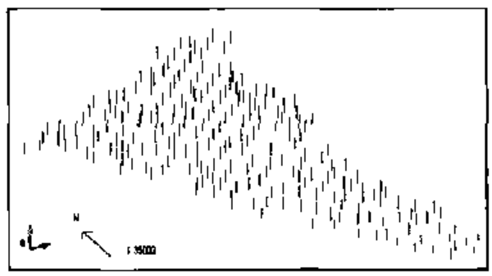

Figure 2 Three-dimensional distribution of drill holes.

Figure 3 Grid mesh imposed on the district.

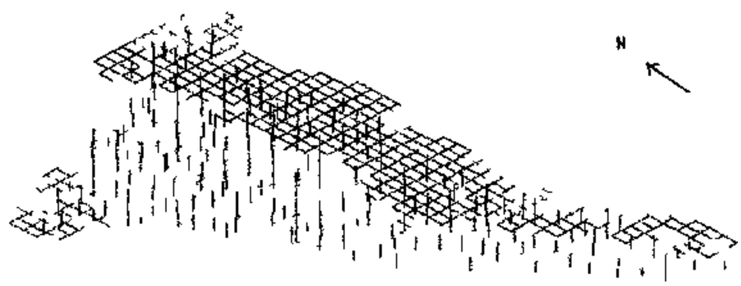

Figure 4 Dnll holes and topography

FigureS Shaded view of topography

The system enables vısuali2atıon of the topography The visual appearance is based on the grid nodes, whose values are assigned by data mterpolation methods The *(x,y,z)* coordinates are calculated and stated in a special drawing format The DXF formatted view of the topography is processed by the Bryce package and after rendenng photograpic quahty views are obtained Figure 6 is an example of rendered topography A 3 dimensional frame is rendered by earth matenal Figure 7 also shows another rendenng matenal from another perspective The visualization has photograpic quality when other effects like clouds are added

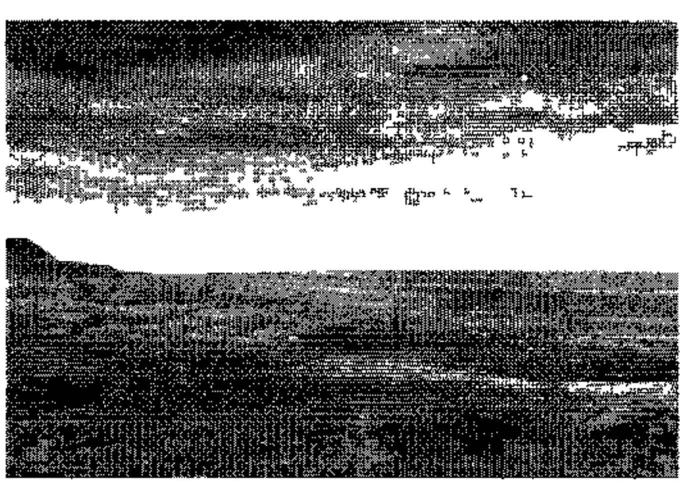

Figure 6 A zoomed view of topography rendered with earth material (some exaggeration in z direction)

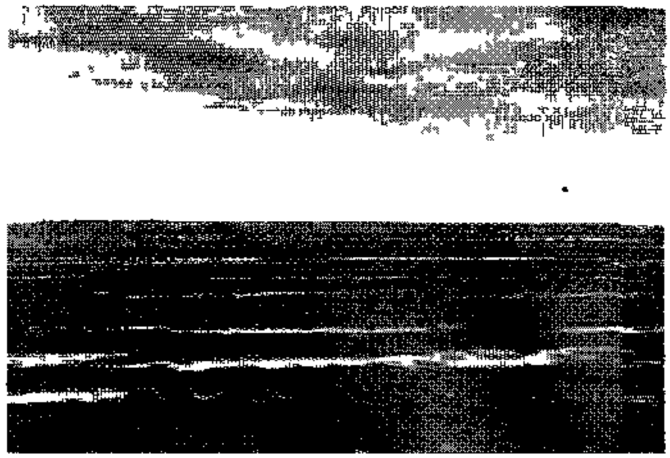

Figure 7 Another zoomed view from the topography with a different rendering materia!

The system interpolates assay values level by level to assign grade or calorific value to blocks A cutoff grade or calorific value will yield the view of the valuable part of the ore body Figure 8 represents 3-dımensıonal block model of the distnct

As can be seen in the figure, the coal seam has a slight tilt (exaggeration in the figure) toward the north The topography and the coal deport can also be visualized together (Fig 9)

The reserve of the ore body, estimated by evaluating 239 drill holes and the ore body block model is 958 3 million tons In comparison to previous studies (Erarslan, 1991), reasonable and logical results reveal that the system developed is suitable and valid for all DXF format processors

Figure 8 Block model of coal seam after rendering

Figure 9 Isometric rendered view of topography and underlying coal seam

The system has also been tested for non-coal deposits (Erarslan, 2000). It has revealed its applicability to all deposits.

4 CONCLUSIONS

Topographical views, 3D ore body models and drill hole diagrams are the visual results of mine evaluation. In this study, a visual evaluation system has been developed. The system is based on drill hole data. Three-dimensional drill hole distribution is visualized by the system. The topography and ore body block model can also be represented İn three-dimensional space. This provides to observe the extensions of the ore body and its underground position. The system also allows for calculation of the reserve using a block model. The outputs of inverse distance methods, geostatistics and neural network systems can be utilized İn visualization. The interpolated data is represented in Data exchange File (DXF) format, which is a simple and practical method of visualization. The system has been coded in C++ and successfully applied in the Çöllolar brown coal district in Elbistan, Turkey.

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